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POLAR ASYMMETRY OF THE PLANETS

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POLAR ASYMMETRY OF THE PLANETS

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ABSTRACT. The asymmetry found in formations on the Earth and on the other planets is discussed. Hypotheses on the reasons for this asymmetry are presented.

With even a very superficial glance at the globe, it can be seen that in /68* the northern hemisphere, north of the 70° latitude, there is an ocean, and in the southern hemisphere — at the same latitudes, it is dry. A belt of continents in the northern hemisphere is opposite a belt of southern seas at a latitude of 40 - 70°. This contrast, asymmetry, is particularly apparent (Figure 1), if we consecutively trace different types of the Earth's surface on an equidimensional projection of the sphere from the central meridian along the latitudinal lines: Continents, continental shelf, continental slope, and ocean floor. Since the middle of the last century, the asymmetry of the surface of the Earth has attracted the attention of many authors, and in our time the following authors have written about it:

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*Numbers in the margin indicate the pagination in the original foreign text.

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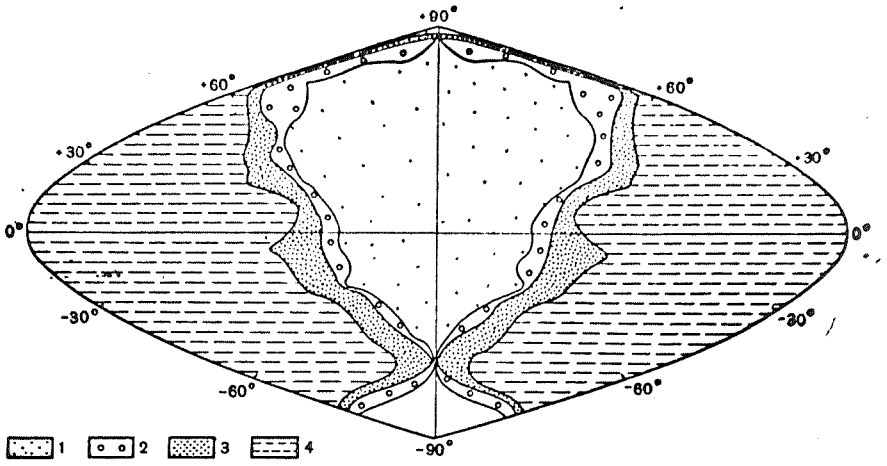

Figure 1. Asymmetrical distribution of formations on the surface of the Earth: The northern hemisphere is more "continental" than is the southern hemisphere (based on maps of I. P. Gerasitov and Yu. A. Meshcheryakov, 1967):

1 — continents; 2 — continental shelf; 3 — continental slope; 4 — ocean floor.

Ya. Ya. Gakkel' and L. P. Shubayev (1962) et al., geologist N. A. Shtreys (1964), when studying the distributions of formations having a different age, found that the intensity of geological processes — particularly, the increase in the crust — beginning with Cambrian times were stronger in the northern hemisphere. On the other hand, the Pre-Cambrian ages are more widely distributed in the southern hemisphere. He called this phenomenon bipolarity. The distribution of tectonic zones on the Earth may possibly be asymmetric with respect to the ancient position of the equator, beginning with the Cambrian period (P. V. Florenskiy, 1962, 1965). The distribution of the hydrosphere and the atmosphere is also asymmetric.

If each section of the Earth's surface is subjected to the same conditions of geological development, then the distribution of oceans and continents, the

granite and basalt layers, mountains, ravines, and generally any structures would be irregular and random. As has been indicated, this is not observed.

The Earth rotates around its axis and rotates very rapidly; a point on the equator moves at supersonic (or air) speed with resepct to a point at the pole. Could the distribution of structures on the Earth be controlled by rotation? But then the continents would be collected — like tea leaves in a glass of tea — at the poles or, on the other hand, at the equator, or they would encircle the Earth in rings. Such a speculative discussion appears to be logical, and could even be applied, for example, to the belt of "seas" on the Moon, which combine into a ring directed toward its present-day equator. It is assumed that this ring corresponds to the position of the equator on the Moon at a time when it rotated more rapidly than it does at the present, and was partially melted. In the locations subjected to the greatest stress, which appeared on the paleo-equator, the seas arose. In discussing these erroneous concepts, we should not forget the role of rotation: On the Earth and on other planets, there is an uneven distribution of formations at different latitudes, but it is observed to an incommensurably smaller degree than in the concepts which explains the belt of "seas" on the Moon. The idea that there are active latitudes and longitudes — critical parallels and meridians — in the shadow of the Earth has been repeatedly discussed at astrogeological conferences organized in Leningrad upon the initiative of the Soviet scientist-encyclopaedist Boris Leonidovich Lichkov[1] (1888 - 1966) and later by his successors. In their opinion, the strongest orogeny occurred at latitudes of 35 - 61°. In the graphs, we have attempted to show the distribution of formations on the Earth. It must be noted that they clearly show in general the latitudes which coincide with the given ones, where the granite and basalt layer is more pronounced: In the northern hemisphere, this is 65 - 55° to 40 - 35°, and in the southern hemisphere it is 15 - 20°. However, in explaining the details of the distribution of various formations, the /69

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(1) See B. L. Lichkov. Natural Waters of the Earth and the Lithosphere. Zapiski Geogr. Obashchestva, SSSR, Novaya Seriya, Vol. 19, 1960.

hypothesis of an unequal distribution of rotational stresses on the planet's surface does not account for the reasons for the asymmetry of the northern and southern hemispheres.

Is this asymmetry apparent in the deep zones of the Earth? In the Earth's core, there is a granite layer which exists only under the continents, and then almost everywhere there is a basalt layer, and beneath them is the mantle.

It is assumed that the crust of the Earth became more composite as it developed: Layers were formed and they were differentiated. The more newly formed layers there were and the more pronounced they were, the more this portion developed. The continent crust, consisting of granite and basalt layers, was more highly developed than the ocean, which consisted only of a basalt layer. The total extent of these two layers changed from a few kilometers under the oceans to 70 kilometers under the continents. The closer the basalt layer and the mantle were to the surface of the Earth, the greater was the force of gravity at that location. Taking into account the deviation of the force of gravity, caused by the different depths of the stratifications and the width of these layers, the Soviet geologist R. M. Deminitskaya (1967) drew up maps showing their distribution for the entire Earth at different depths. Based on these maps, we have compiled graphs in an equidimensional projection of the sphere (Figure 2). In these graphs, on both sides of the axial meridian there are areas occupied by a granite layer, basalt layer, and a mantle at depths of 10, 20, 30, 40, 50, 60, 70 km. It can be clearly seen that the layers corresponding to a higher degree of differentiation (basalt and granite) are concentrated at the middle latitudes of the northern hemisphere. Thus the distribution is complicated by peaks corresponding to the active latitudes. The polar asymmetry is thus one of the general properties of the Earth as a whole, and it is clearly apparent in its geological strata.

However, can this asymmetry be a characteristic of the Earth alone? Or can it belong to other planets?

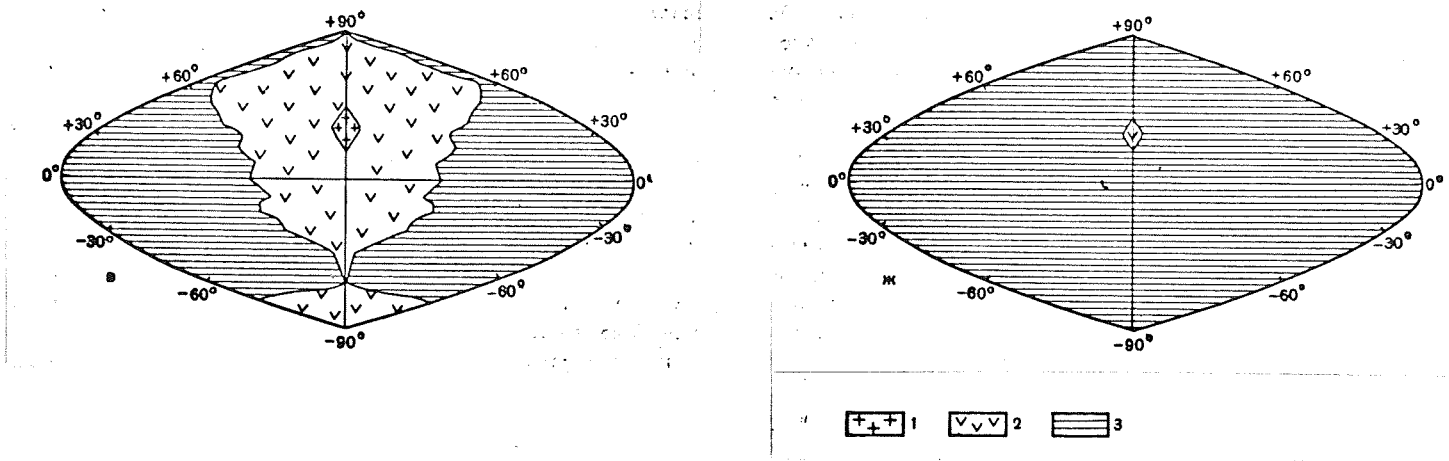
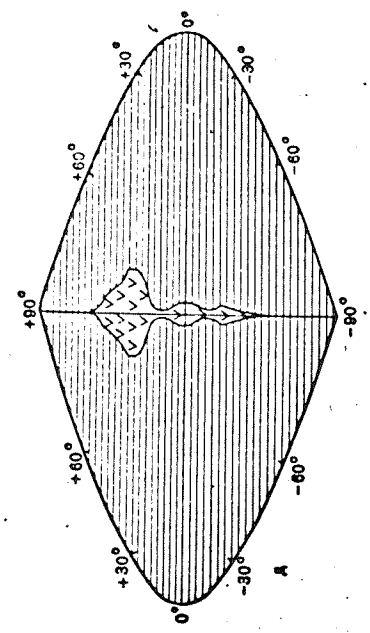


Figure 2. Asymmetry of the surface of the Earth followed uniformly with respect to the areas occupied by granite and basalt layers and mantles at various depths (diagrams are based on maps by R. M. Deminitskaya, 1967). There are more widely distributed and extensive granite and basalt layers in the northern hemisphere than there are in the southern; therefore, the northern hemisphere is more developed than the southern. Just as in Figure 1, these diagrams reveal deviations in the distribution of formations corresponding to active latitudes of 65 - 55° and 40 - 35° at a depth of:

a - 10 km; b - 20; c - 30; d - 40; e - 50; f - 60; g - 70. 1 — granite layer; 2 — basalt layer; 3 — mantle.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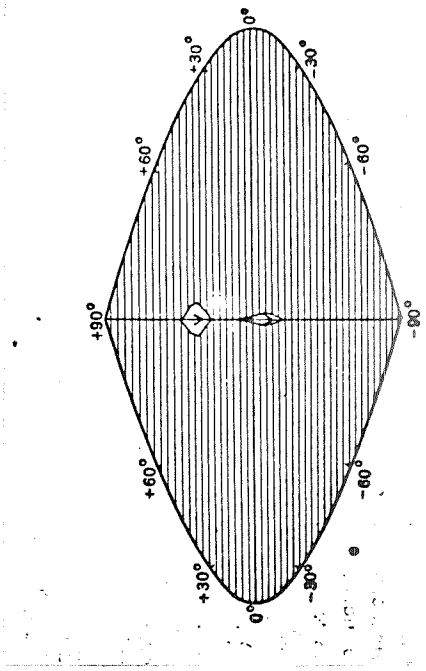
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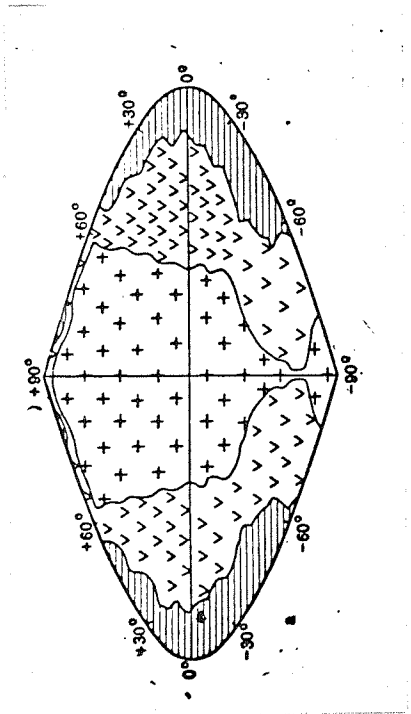
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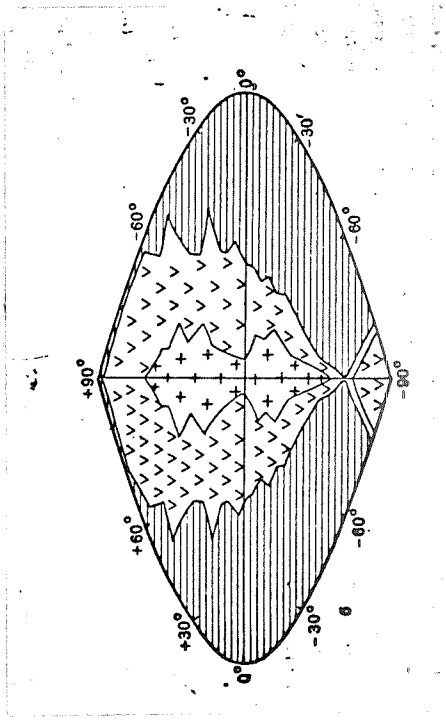
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On the Moon, whose radius is almost four times smaller than the radius of the Earth, even the unaided eye can see dark "seas" and light "continents". Examining the large-scale photographs of its surface, made with a good telescope or with artificial satellites, it can be readily seen that the cracks, fissures, mountain ridges, and cirques "plunge" under the "seas" and mountains which cover them, thus "flooding them". In the opinion of the majority of selenologists, the "seas" were formed as the result of a gigantic eruption of magma and displacements of sections of the lunar surface under its attraction, therefore, the "seas" are not younger or more complex structures than the continents. The "seas" are uniformly attracted primarily to the northern hemisphere of the Moon, and their distribution is similar to the distribution of the basalt layer of the Earth at a depth of 30 - 40 kilometers (Figure 3). It is remarkable that the distribution of "seas" and "continents" on the Moon and the relationship of dark and light regions on Mercury is the same (Figure 4). On Mars the relationship of light, reddish "ravines" and dark, bluish "seas" is also aysmmetrical (Figure 5). Asymmetrical properties are also apparent on satellites of the giant planets. The giant planets themselves are also asymmetrical: The dark bands of the southern and northern hemispher of Jupiter, Saturn, and probably Neptune are asymmetrical. In the southern hemisphere of Jupiter there are two details which disturb the uniformity of its parallel bands: the red spot and the southern tropical disturbance. Although the giant planets are surrounded by powerful atmospheres and hydrospheres, they differ greatly from planets in the terrestrial group not only in terms of size, and in other properties, and polar asymmetry is intrinsic to them. Over the surface of the Sun, the distribution of spots and other indications of its activity is somewhat asymmetrical.

In discussing the development of noncelestial bodies, B. L. Lichkov advanced the assumption that the degree to which the planets developed depends on their size and mass, which determine the force of gravity. The magnitude of the latter determines the possible existence on the planet of migratory areas — the hydrosphere and atmosphere, the nature of the geological processes, and the entire geological development of the planet. Based on this, we may

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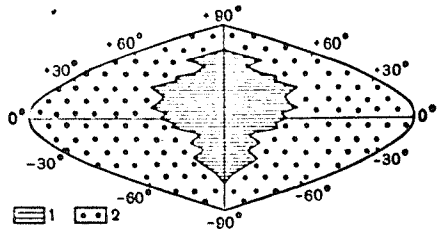

Figure 3. Asymmetrical distribution of the younger "sea" surfaces on the Moon is similar to the distribution of the basalt layer and mantle on the Earth at a depth of about 35 kilometers.

1 — "seas";2 — "continents".

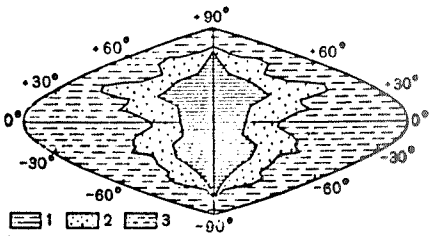

Figure 4. Approximate distribution of dark and light surfaces on Mercury. Although it differs greatly according to the maps of various observers, it is asymmetrical everywhere, and the diagrams are similar to diagrams on the Earth at a depth of 25 - 30 kilometers or on the Moon. The graph is based on two maps of Mercury: The dark regions (1) — based on a map by K. Chapman; the dark regions (2) and the light rigions (3) — based on a map by O. Dol'fyus and Zh. Kamitel'.

reach a conclusion regarding the general laws which govern the formation of a crust for planets in the terrestrial group, of which the largest is the Earth, and its satellite is the Moon which is smaller than Mercury. All of these planets of the terrestrial group, except for Venus (its surface has not been studied, since it is covered by clouds) have polar asymmetry. The degree of asymmetry is greater, the greater is the degree to which the planet has developed. On the Earth and on the Moon, there are areas with a more developed crust in the northern hemisphere than there are in the southern hemisphere: On the Earth this is continents with granite and basalt layers, and on the Moon it is "seas". The relationship of the layers changes gradually from the surface to the deeper zones on the Earth, while in the northern and southern hemispheres the picture is somewhat different (Figure 6).

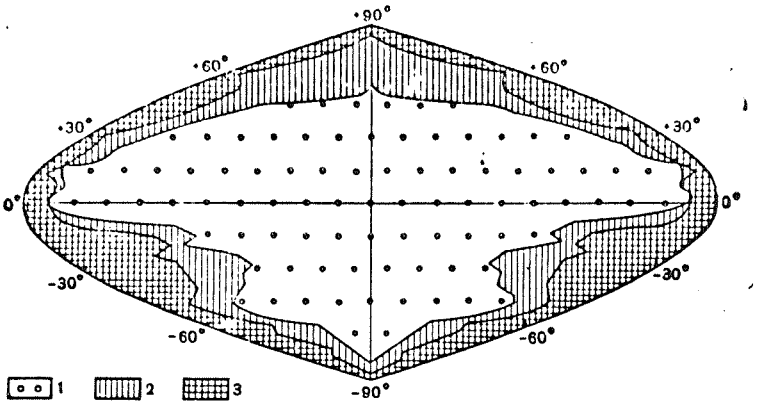

Figure 5. In the northern hemisphere of Mars there are light, reddish "deserts", and in the southern hemisphere there are well-developed and dark green "seas". Their relationship is similar to the distribution of formations on the Earth at a depth of 15 - 20 kilometers.

1 — light reddish regions; 2 — regions which are transitional in terms of color; 3 — dark green regions.

If our conclusions are valid, the planets (Table 1) may be arranged in order in terms of magnitude, which will correspond to the asymmetry and development of their crust: The Moon (diameter 3476 kilometers), 20% of its surface comprises the young "sea" formations; Mercury (diameter 4860 kilometers), 20 - 40%, is a dark surface; Mars (diameter 6769 km), 50 - 65% of the surface is a light red color, and the remaining part is a dark green; the Earth (diameter 12,742 km), 30 - 40% of its surface is a granite crust, and the remainder is basalt. Outcroppings of a mantle on the floor of the oceans is problematical. The distribution of formations on the Moon is close to the distribution of the mantle in the basalt layer on the Earth at a depth of about 35 km. Mercury is similar to the Earth at a depth of 25 - 30 km; Mars is similar at a depth of 15 - 20 km.

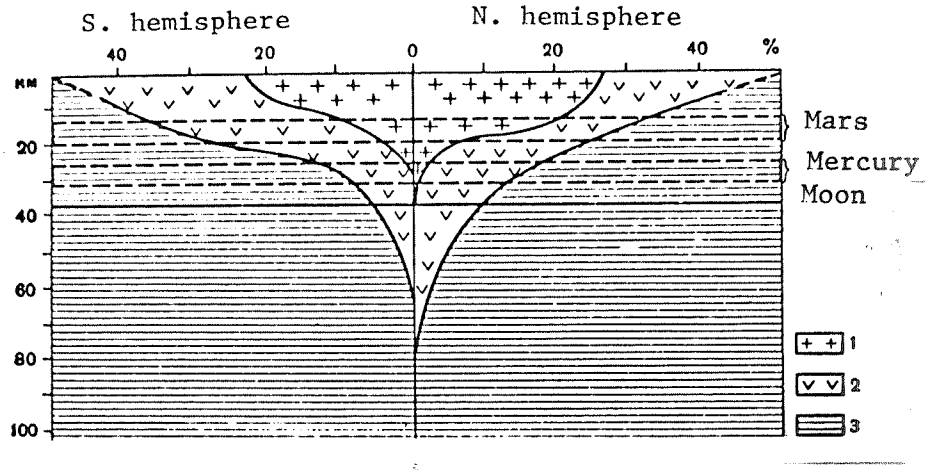

Figure 6. Relationships of layers on the Earth (along the horizontal, in %) at different depths (along the vertical) in the southern and northern hemispheres, as compared with the distribution of formations on the surface of other planets. Depths on the Earth, where the distribution of layers is similar to the distribution of formations on the planets, are distinguished by heavy and lines and dashed lines (problematically).

1 — granite layer; 2 — basalt layer; 3 — mantle.

TABLE 1. CERTAIN PLANETARY CHARACTERISTICS

	Diameter, mm	Mass		density, g/cm^3	Acceleration of gravity		Rotational velocity around axis, days	mean distance from Sun, mill. km
		10^{26} g	In fields of Earth		cm/sec	In fields of Earth's accel.		
Earth	12 742	597,6	1	5,52	978	1	1	149
Venus	12 105	486,7	0,815	5,22	886	0,90	243	108
Mars	6769	64,43	0,108	3,97	372	0,38	>1	278
Mercury	4860	33,03	0,056	5,59	372	0,38	57	58
Moon	3476	7,35	0,012	3,35	162	0,17	27	149

Thus for the geological life of the planets, "upper" and "lower" are important: In the northern "upper" hemisphere, the development of their surface is somewhat different than in the southern hemisphere, and is probably more intense. The question naturally arises of why? Where can we find the answer? One of the ways to answer this is by analogy, or more precisely, homology. First we study the rough, external factors, then the internal ones, which consist in understanding the causes for the similar phenomena. Everything is homotypic, i.e., monotypic, and by knowing the parts, we can understand the whole. "Everything which takes place below is similar to that which takes place above", wrote Hermes Trismegist in ancient Egypt in "Emerald Tables". Therefore, man is not only a judge, but indeed is a measure of all things. The ancient astrologers looked for answers to the problems of man in space, and studied it, attempting to solve the problems of the universe. These ideas were apparently reconsidered at the beginning of the last century. The great naturalist and thinker, the poet Wolfgang Goethe, the author of the scientific concept of "morphology" when considering a single "science regarding the form, formation, and transformation of organic matter", assumed that symmetry is one of the properties of nature. Louis Pasteur, many of whose studies analyze symmetry, in his last writing in 1884 felt that the reasons for the difference between living matter and inert matter may be found in their dis-symmetry. Developing his ideas, "one of the greatest naturalists", in the opinion of V. I. Vernadskiy, Pierre Curie connected the asymmetry of natural /72 phenomena with the general state of matter on the Earth. The idea of the asymmetry of the natural substances and phenomena is expresed in one of the most important books by V. I. Vernadskiy "Chemical Structure of the Biosphere of the Earth and its Surroundings" (Moscow, "Nauka" Press, 1967). In the opinion of V. I. Vernadskiy, asymmetry — i.e., incomplete disturbed symmetry — is characteristic of geologic strata on the surface of the Earth, including the granite layer, and is revealed in their unequal distribution. One of the particular cases of asymmetry on the Earth is the opposite positions of its northern and southern hemispheres, which is described in the geological literature as polar asymmetry.

To what is the asymmetry of the planets related? What causes this characteristic structure of their crust, which is the same in different planets? Pierre Curie assumed that a body in nature must be studied only together with the conditions under which it exists. He believed that the symmetry in the surroundings was imposed on the symmetry of a body which is produced and exists in these surroundings. In an area whose properties are the same in all directions — the area is isotropic — a sphere may be formed, for example, an air sphere in air and a bubble in water. Another case is bodies existing in an area whose properties change in different directions — an area which is anisotropic — for example, in a river or in our gravitational surroundings where gravity has an influence upon us. In all of these bodies there is the opposition of a "head" and "tail", or "above" and "below", whether it be fish in a river or forests, or smoke coming from a chimney. Animals, or finally we ourselves, carry the print of this nonuniformity — anisotropy, the asymmetry of the medium in which we exist.

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